

# The Effectiveness of SMASSE Teacher Training Programme on KCSE Performance in Mathematics and Chemistry Subjects in Kikuyu District, Kenya

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## Abstract

The changeover of the Kenyan system of education from the 7-4-2-3 to the current 8-4-4 in 1984 made science subjects (Biology, Chemistry and Physics) compulsory to all students up to form two at the secondary school level. This meant increased numbers of students in one class at a time attending the science subjects, which may compromise quality. The quality of secondary teachers and teaching is, however, influenced by many small factors rather than a few large ones. This paper is an investigation into the effectiveness of Strengthening Mathematics and Science in Secondary Education (SMASSE) training of mathematics and chemistry teachers on the Kenya Certificate of Secondary Education (KCSE) performance in Kikuyu District. The study used sixteen schools selected by stratified random sampling method. This study gathered both qualitative and quantitative data. Data analysis was done using Statistic Package for Social Sciences (SPSS) software, Registered R and Excel. Findings are presented using percentages, trend lines, frequency distribution and means. The study findings indicate that SMASSE In-service and Education Training (INSET) has no impact on the performance of mathematics and chemistry, the Activity, Student-centered, Experiment, Improvisation (ASEI) and Plan, Do See Improve (PDSI) approaches are in use and have improved the teachers' confidence and ability to deliver, and the skills learnt are effective. Thus this study concludes that though SMASSE INSET does not show impact on the performance of mathematics and chemistry, it has influenced the teachers' ability to deliver in their teaching amidst various challenges. The research recommends that future SMASSE programmes should have a bottom up approach to enable full ownership and participation by key stakeholders.

**Keywords:** Teacher training, SMASSE, INSET, Student performance, Effectiveness

## 1. Introduction

### 1.1 Teachers' Training

Teachers remain one of the most important human resources that a country can have. This is because the efficient human capital development depends partly on the quality and effectiveness of the teachers (Okumbe, 1999). The quality and effectiveness of the teacher is among others a function of the talent and the training. According to Moraga (1983) training of teachers is one of the most important aspects of curriculum development and implementation in any education system. Ideally training of teachers should have a pre-service and in-service component. In a news letter in 2005, Assistance for Development of Education in Africa (ADEA, 2005) stated that the adequate pre-service training notwithstanding, (which is just sufficient for an orientation of the teacher into the profession), the real teacher is generally formed in the classroom. ADEA (2005) further asserts that mathematics and science education development especially at the secondary level is a prerequisite for industrial and technological development. In the past, great efforts have gone into ensuring qualified teachers and provision of equipment and materials, but in most cases science and mathematics teachers remain inadequate in most African countries. Even where they are adequate, quality of students' achievement in mathematics and sciences education is not always high.

It is with this background that the attention is now drawn to what classroom practices, utilization of the available equipments and materials, and approaches and methodologies that are employed in content delivery (ADEA, 2005). This is a critical component to the answer to mathematics and science education problem (ADEA, 2005). This is the basis for the Strengthening Mathematics and Science in Secondary Education (SMASSE) project with an In-Service Education Training (INSET).

Consequently, AED (2005) recommends a strong ongoing in-service professional development program for secondary teachers that will support them throughout their teaching careers. This seems to fit into the Kenya government collaboration with Japan International Cooperation Agency (JICA) in coming up with the SMASSE project.

## 1.2 The SMASSE Project

SMASSE project started offering INSET to mathematics and science teachers in Kenya since July 1999 on a pilot basis. In July 2003 the SMASSE project Phase II was started and INSET was extended to all mathematics and science teachers in Kenya. Almost 90 percent ( $n = 18000$ ) have since been trained (SMASSE, 2007). INSET was found to be essential for the updating the knowledge and improving the professional competence of teachers. SMASSE project was done in four cycles dealing with specific aspects:

### 1.2.1 Cycle one: Attitude Change

This lays emphasis on attaining positive attitude change towards mathematics and science education among the teachers. Positive attitude is seen as a prerequisite to teachers embracing the ideas that SMASSE expounds.

### 1.2.2 Cycle two: Hands on Activities

This is hands on activities/practical work oriented. It provides for participants the opportunity to experience an assorted hands-on activities/practical work with a view to enhancing their skills in designing relevant teaching/learning activities that promote student interest and understanding.

### 1.2.3 Cycle three: Actualization

The 3<sup>rd</sup> cycle of INSET focuses on actual classroom implementation of the principles of ASEI/PDSI that is actualization of ASEI/PDSI. INSET participants plan for, implement and discuss ASEI lessons during peer teaching sessions and then proceed to schools for actual classroom implementation. To augment effective classroom implementation of the lessons, the cycle of INSET includes sessions on monitoring and evaluation with bias towards classroom observation.

### 1.2.4 Cycle four: Monitoring and Evaluation

The 4<sup>th</sup> cycle of INSET's main objective is to tie loose ends from the three basic cycles before releasing participants to plan, organize and implement District INSET on their own. It is a capacity building session to ensure efficient, effective and self-reliant District INSET system. In addition cycle four focuses on the critical issues of impact transfer with participants discussing indicators for positive impact of SMASSE-INSET activities both on teachers and students (SMASSE-WECSA, 2006).

Going by the words of Duff (1988), "training is most effective when urgently needed and when the reasons for the urgency are clear," the SMASSE INSET was very timely for Kenya.

## 1.3 Performance in Mathematics and Sciences in National Examinations

Studies have shown that science is for all students regardless of their age, sex, cultural or ethical background, disabilities, aspiration or interests and motivation in science. They have shown that all have the opportunity to attain high scientific literacy. The learning of science is an active process. This learning is something the students do, not something that is done for them. According to Organization for Economic Co-operation and Development (OECD, 2004), most children come to school willing and ready to learn. Schools must therefore strengthen this predisposition by developing their altitude and skills so that the students can acquire new knowledge and skill necessary for successful adaptation to changing circumstances.

However this is not necessarily the case in our secondary schools. It has been argued that most science and mathematics teachers underwent traditional didactic instruction during the initial training and hence need to expose these teachers to the new methods of teaching. This implies that there is need to practically look into the teaching methodology and strategies employed by the teachers through in-service training.

At the national level performance in sciences has been poor for both girls and boys (TSC, 2005) as shown in Table 1. Performance in mathematics has been the poorest followed by that of chemistry. Though the performance of physics has still been poor, only a few students sit for the subject as indicated.

Table 1: Performance in mathematics and sciences at the national level

Subject	2004		2005		2006		2007	
	Female	Male	Female	Male	Female	Male	Female	Male
	Mean %							
Mathematics	15.39 *102041	21.34 *119254	12.97 *118898	18.49 *140414	15.78 *113803	21.87 *128323	15.74 *124874	23.10 *147387
Physics	31.41 *16966	35.25 *43116	32.85 *19288	35.99 *50136	39.07 *21376	40.82 *51123	39.04 *23767	42.23 *59506
Chemistry	25.79 *99558	30.43 *114962	24.54 *116826	29.44 *136684	22.56 *111696	27.01 *124932	22.65 *122532	27.69 *144229
Biology	32.91 *97647	37.64 *103156	27.24 *113605	32.01 *121370	25.00 *108065	29.84 *109863	38.99 *118395	44.70 *127516

\* Represents n, the number of candidates who sat for specific exams

Source: The KNEC's KCSE examination reports for 2004, 2005, 2006 and 2007

From Table 1, the number of students sitting for physics is less than 25% and about 30% for female and males respectively when compared to those sitting for mathematics. The number sitting for both chemistry and biology almost tarry throughout the years but on comparing physics with chemistry and biology, the number sitting for physics is less than 25% for females and less than 50% for males. From the data in Table 1 it is evident that, compared to mathematics and chemistry, the number of students doing physics is small.

## 2. Materials and Methods

The study was carried out in Secondary schools in Kikuyu District in Central Province. Kikuyu District is one of the recently formed districts having been curved from the greater Kiambu West District. It is a highly populated peri-urban area approximately 20 kilometers west of Nairobi, the capital city of Kenya. The study adopted a cross-sectional study design representing a snapshot of one point in time and descriptive in nature (Jupp, 2009) seeking to determine the influence of SMASSE training in dissemination, understanding of mathematics and chemistry and the actual performance in KCSE. According to Kombo and Tromp (2006) the major purpose of descriptive research is description of the state of affairs as it exists. Descriptive research can result in formulation of important solution to significant challenges and problems. The study was confined to form two students of both public and private secondary schools in the district. The schools were sampled by stratified random sampling from the total number of national, provincial, district and private secondary schools in the district. The sample population comprised secondary schools in Kikuyu District. Kikuyu District was selected as it is one of those that benefited with the initial SMASSE trainings. It was also curved from the district that had been performing poorly in KCSE in Central Province. According to KNEC, (2002) there were 27 public and private secondary schools in the district that sat for KCSE in 1999.

The sample size constituted sixty percent of the secondary schools in Kikuyu district as at December 1999. Using the following formula:

$$\text{Total number of schools in the stratum (N)} \times 60\% = 16 \text{ schools}$$

Total number of schools in the district (T)

$$\text{National} = 2/27 \times 16 = 1.19 \approx 1 \text{ school}$$

$$\text{Provincial} = 4/27 \times 16 = 2.4 \approx 2 \text{ schools}$$

$$\text{District} = 14/27 \times 16 = 8.3 \approx 8+1 \text{ schools}$$

$$\text{Private} = 7/27 \times 16 = 4.1 \approx 4 \text{ schools.}$$

The total sample size of the population was:-

$$8 \times 5 = 40 \text{ students in focus group}$$

$$2 \times 16 = 32 \text{ mathematics and chemistry teachers}$$

$$1 \times 16 = 16 \text{ principals of the sampled schools}$$

$$\text{Total} = 40 + 32 + 16 = 88 \text{ persons}$$

Questionnaires, review of available documents, and focus group discussions were used to collect data for the study. The analysis for the qualitative data obtained from the focus group discussion involved qualitative techniques. Quantitative data was on the other hand analyses using SPSS.

### 3. Results and Discussion

#### 3.1 Influence of SMASSE on KCSE Performance of Mathematics and Chemistry

##### 3.1.1 Performance in mathematics

Out of the sixteen schools sampled none of them showed a significant improvement in KCSE mathematics since the inception of SMASSE. Almost a half of the school (43.75%) had their performance remaining nearly constant over the years (1999-2008) (an increment of less than 0.05 points over the years on study); a quarter of the schools (25%) showed some deterioration (a negative increase in points in the school's mean grade over the years under the study) in performance in mathematics. However, more than a quarter (31.25%) showed some improvement (an average increase of more than 0.05 points in the school's mean grade over the years under the study) in their performance in mathematics.

On regression, the data from those schools that had shown some improvement since inception of SMASSE showed no significant difference between the pre and post SMASSE performance as shown in figure 1 and figure 2. The improvement was however not significant at  $\alpha < 0.05$ .

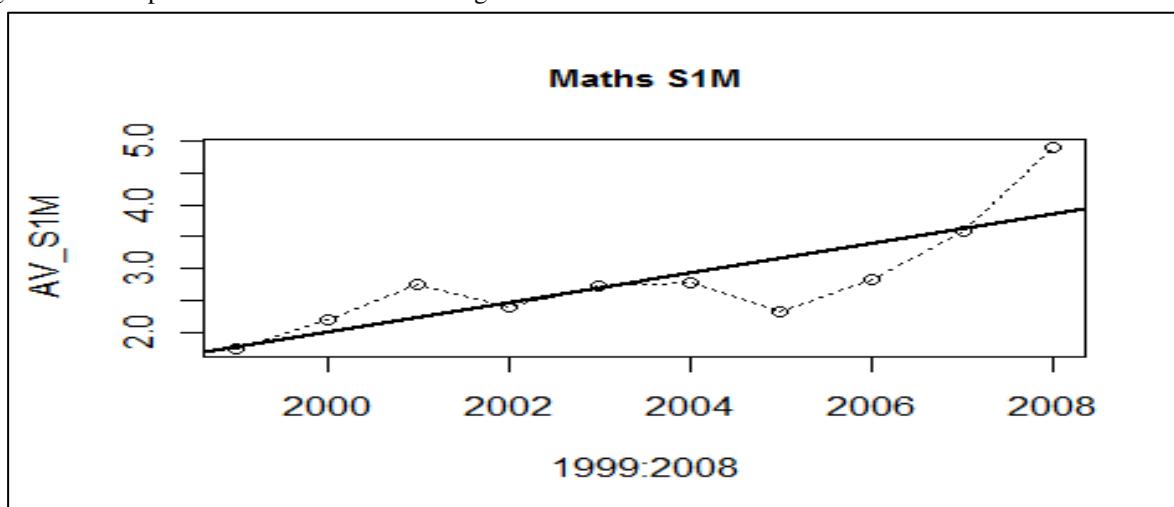


Figure 1: Performance in Mathematics in the most improved school

Regression formula:  $y=1.55+0.2x$

Analysis of Variance Table

Response: AV\_S1M

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
SMASSE	1	2.0976	2.09764	3.4999	0.09829.
Residuals	8	4.7948	0.59935		

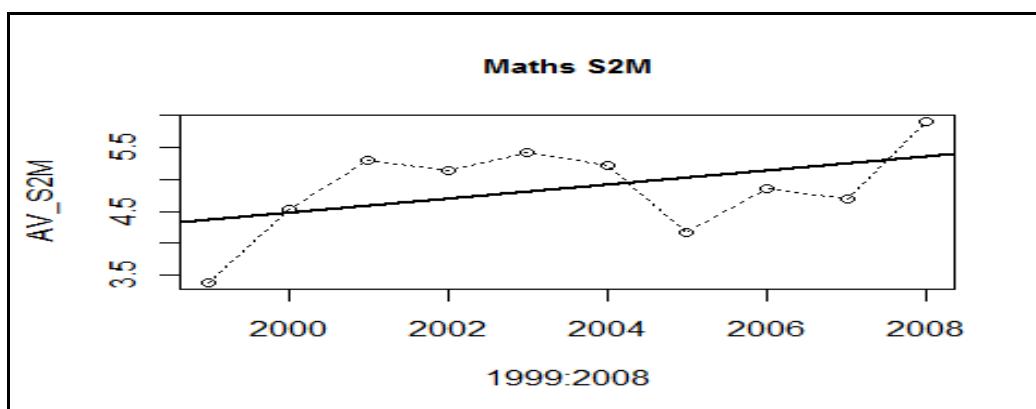


Figure 2: Performance in mathematics in the 2<sup>nd</sup> most improved school

Regression formula:  $y=4.25+0.11x$

Analysis of Variance Table

Response: AV\_S2M

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
SMASSE	1	0.1103	0.11025	0.1985	0.6678
Residuals	8	4.4444	0.55555		

### 3.1.2 Performance in chemistry

More than half (56.25%, n=16) of the schools sampled showed an improvement (an average increase of more than 0.05 points in the school's mean grade over the years under the study) in their performance in chemistry. On regression, the improvement was not significant at  $\alpha < 0.05$  as illustrated in figure 3. The p-Value for the figure 3 was 0.067.

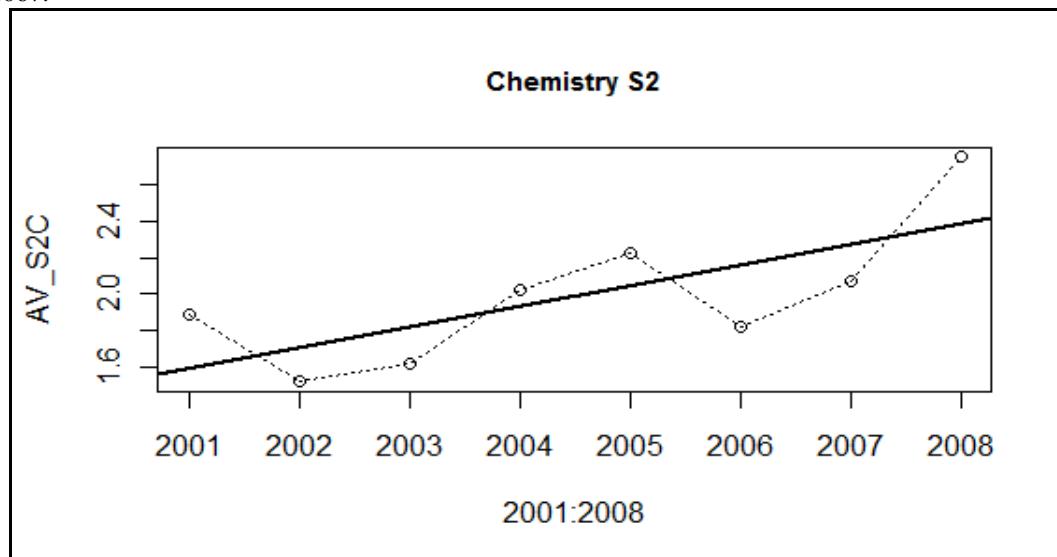


Figure 3: Performance in chemistry in the best improved school

Regression formula:  $y=1.48+0.11x$

The best improved school in Chemistry as illustrated in figure 3 showed a consistent improvement of an average of 0.27 points per year for seven years. Some schools (18.75%) showed deterioration (an average increase of less than 0.00 points in the school's mean grade over the years under the study) in performance in chemistry while the rest gave almost constant (an average increase of less than 0.05 points in the school's mean grade over the years under the study) performance.

### 3.2 Effectiveness of SMASSE Skills Learnt

Overall the teachers noted that the skills learnt in SMASSE INSET are effective and applicable in teaching mathematics and chemistry. Almost all the respondents (93.1%, n=29) noted that they were interested in their learners and the difficulties they face in learning mathematics/chemistry as shown in figure 4.

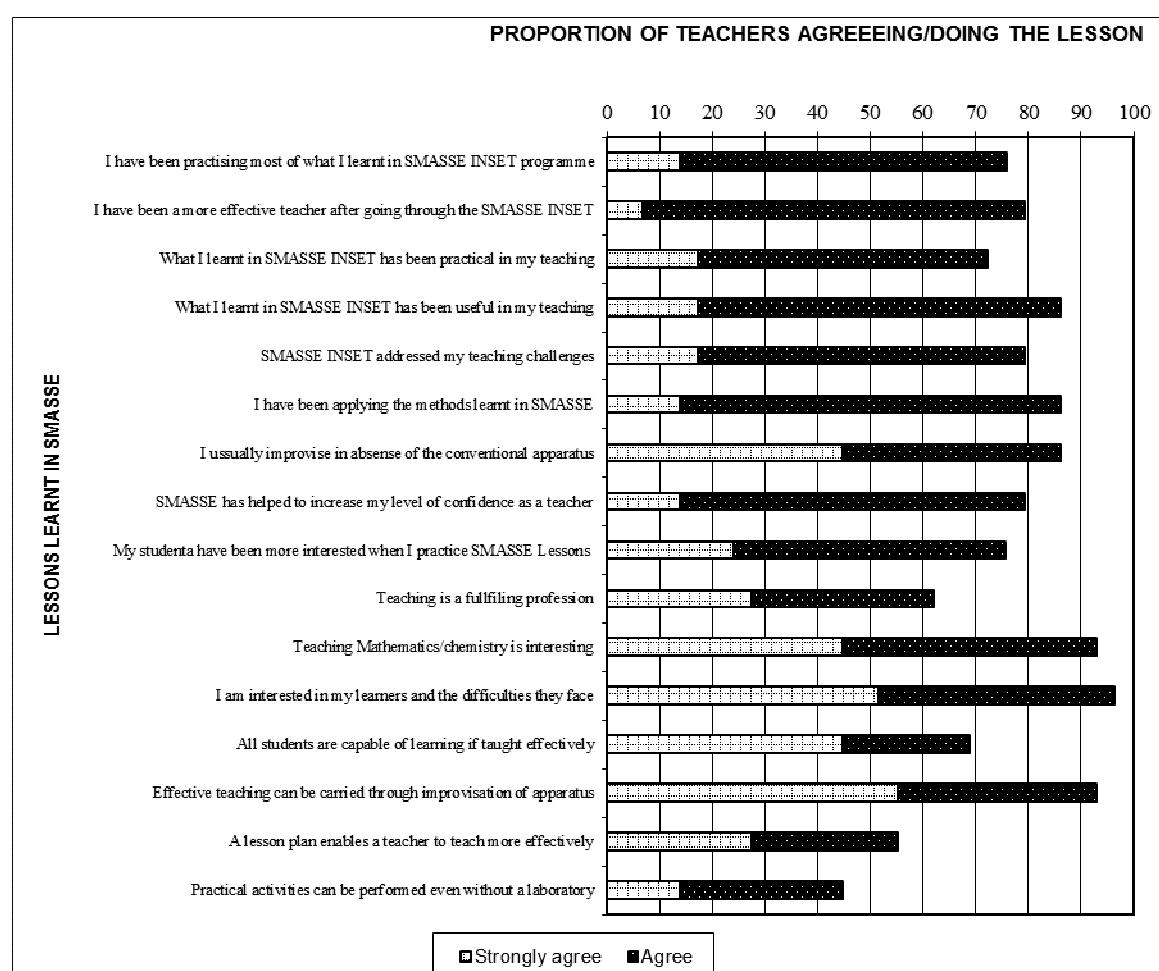


Figure 4: Effectiveness of SMASSE skill learnt; teachers' opinion

However, only about half of the teachers (45%, n=29) were of the opinion that practical activities can be performed even without a laboratory. The opinion of the teachers was however refuted by the students who noted that the teachers are only interested on the bright students and tend to ignore the others in class. Some reservations were also expressed by teachers over the point that lesson plans enables a teacher to teach more effectively. Of concern was the fact that only about half the teachers (60%, n=29), agreed to the idea that teaching is a fulfilling profession. This is evidence that the teachers attitude to teaching has not changed even after going through the SMASSE training program.

When asked to note the skill they gained in SMASSE INSET, improved teaching methods, improvisation of apparatus and making ASEI lesson plans were noted. The skill on how to mark exams had only been achieved by a minority as shown on Table 2.

Table 2: Skill gained during SMASSE

Learnt skill	Frequency (N=37)	Percentage (%)
Improved teaching method	10	27
Improvisation of apparatus	9	24.4
Practical skills	7	18.9
Making ASEI lesson plans	6	16.2
Good management of time	3	8.1
How exams are marked	1	2.7
No comment	1	2.7

### 3.3 Opinions of the Principals

Most of the principals (66.7%, n=15) confirmed that SMASSE INSET has had significant effects on teaching in their school. Their responses included; the INSET has been useful (60%), has made teachers more effective (53.3%), and the needs of the school in teaching mathematics and chemistry were addressed (63.4%, n=15). Less than half of the principals (40%, n=15) noted that the teachers had been applying the approaches learnt in SMASSE INSET with a similar number being of the opinion that the teachers level of confidence when teaching has increased. When asked whether the students are more interested and enthusiastic about learning mathematics and chemistry, only 40% agreed. This was also the case when they were asked whether the teachers find teaching a more fulfilling profession as a result of SMASSE INSET programme with only 26.7% agreeing, 33.3% not certain and 40% strongly disagreeing. Only about a quarter of the principals (26.7%) agreed to the statement that the learners find mathematics and chemistry interesting.

Most of the principals (66.7%) felt that the teaching of mathematics and chemistry is now more student-centered than teacher-centered, teachers are more innovative in improvisation after going through SMASSE INSET(60%), that effective teaching has resulted in better performance of students in examinations (66.7%) and there is more effective use of chemistry facilities after the INSET. Contrary to the high percentage above, less than a half of the principals (40%, n=15) felt that the INSET had the intended influence on how the teachers teach. This shows that responses from the principals were not consistent.

### 3.4 SMASSE INSET Influence on the Teaching Method

Though all the teachers noted that they had gained from the INSET, a few (17.2%, n=29) noted that this did not influence their way of teaching. When asked about the significance/ usefulness of the course, a number of teachers noted that it made them more effective in teaching in addition to bringing them together so that they can exchange ideas. A few (13.7%, n=29) however, noted that the course was not necessary. When asked of the effect of the application of what they learnt in SMASSE INSET on the students, most of the teachers gave multiple responses. About a half (48.3%, n=40) noted that the students were now more motivated, while 31.8% felt that the students performance has improved. On the effects of the SMASSE INSET in their teaching the teachers gave the responses shown in Table 3.

Table 3: SMASSE INSET influence on teaching

Influence on teaching	Frequency (N=32)	Percentage (%)
Involving students more in practical work	8	25
Proper planning of every lesson	4	12.5
Giving practical approach to difficult topics	8	25
Help students answer exam questions correctly	1	3.125
Teaching at the pace of the learner	1	3.125
Boosted teachers confidence	5	15.625
None	5	15.625

Given the opportunity to comment on the general effectiveness and impact of the SMASSE INSET on their teachers and students, the principals gave the comments as shown in table 4.

Table 4: Principals comments on the impact of SMASSE on teachers and students

Principals comment	Frequency	Percentage n=14
Teachers are very negative about the programme, no ownership of the programme by the teachers, teacher complain about poor facilitators	2	14.3
Has no impact, teachers are unwilling to change their attitude	3	21.4
There is more effective teaching	7	50
Students have negative attitude to sciences and mathematics	2	14.3

These findings agree with Kagenyi (2008) who noted that some teachers attended the programme by force and are not willing to participate in discussion. They go to the INSET centre to sign that they are present but not to participate in the training. Kagenyi (2008) also noted that SMASSE also had some benefits in that the teachers

socialize, get exposure to different students and school environment, and have hand-on experience during INSET sessions.

#### 4. Conclusion

Analysis of the mathematics examination results showed no significant difference between pre and post SMASSE. This implies that SMASSE had no impact on the performance in the subject. The trend however shows some improvement in some school which could lead to significant improvement with time. Such an improvement will depend on the sustained use of skills learnt in SMASSE INSET among other factors. Chemistry results showed a similar pattern but the results from pre-SMASSE could not be used for analysis. This is because pure chemistry became compulsory in KCSE in 2001. There before, pure chemistry had been reserved for the bright students as reported by the principals of schools. The rest of the students sat for physical sciences.

The responses on the effectiveness of the skills learnt showed that the teachers appreciated the skills. However it was clear that the teachers only applied the skills they thought were convenient in addition to what they traditionally did. Some of the skills learnt were found to be burdensome and time consuming.

The principals' opinion on effectiveness of SMASSE also showed mixed reactions. Change of the teachers' attitude to teaching was still not evident nor was the appropriate use of SMASSE skills learnt. The fact that some noted that the course is not necessary and to some it has no influence on their teaching is an indication that there is need to refocus the program to improve its effectiveness.

#### 5. Recommendation

The ministry of education should look for more innovative ways of motivating teachers to improve on their performance in teaching science and mathematics. Teachers of Science should have a reduced workload to give them adequate time to plan and prepare for the lessons

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